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DIGITALLY TRANSFORMING ORGANISATIONS: A REVIEW OF CHANGE MODELS OF INDUSTRY 4.0

Research paper

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Abstract

Managers understand the digital transformation, but do not always know how to apply it in their organisation, and how to manage the changes it introduces. Moreover, publications on the subject of the digital transformation often focus on the assessment of the current position of an organisation, or on technological aspects. The question of “how” to support managers in the organisational change remains open. This paper aims at analysing this gap by reviewing publications suggesting change models, including models mentioning steps or stages of transformation. Results show no publication has studied a business-wide transformation; most focus on a few subjects such as business model and processes. Furthermore, structured approaches to change management are suggested, which is little appropriate in a constantly changing environment. Finally, a few authors suggest the development of dynamic capabilities could provide basis for a successful transformation. We suggest that both structured methods and developing capabilities are necessary, but flexibility is required in the change management approach due to the uncertainty of the environment.

Keywords: Digital transformation, Organisational change, Change Management, Dynamic capabilities.

1 Introduction

While enterprises have a good understanding of the impact of the digital transformation and its requirements, they struggle to apply the transformation, notably when integrating digital solutions in their core business and identify new governance models, according to a recent study of 4,000 CIO and IT managers (*The transformational CIO*, 2018). Initially introduced as a way to leverage new technologies to face modern challenges, such as resources scarcity, global competition, and demographic changes (Kagermann, Wahlster and Helbug, 2013), the concept of Industry 4.0 was quickly grouped with the notion of a digital transformation of organisations, to emphasize the organisational changes needed to reach the aforementioned goals (Shaughnessy, 2018). The term Industry 4.0 was initially meant to represent the German branding of the post-2010 digital transformation of organisations, but gained general popularity in scientific and professional spheres as the introduction of cyber-physical systems and data-analysis related technologies in business operations (Issa *et al.*, 2018). The concept of digital transformation precedes Industry 4.0 by several decades, but in the more recent years the “digital” aspect has moved away from the computers themselves, and closer to mobile technologies and massive data analysis as a way to transform business models (Schallmo, Williams and Boardman, 2017). In the most recent interpretation of the digital transformation, the volume of data coming from sensors or internet sources has increased to the point that new data analysis techniques are required if organisations wishes to integrate them in their business models to improve their performance (Schallmo, Williams and Boardman, 2017).

In addition to the technological drivers, digital strategies (Kane *et al.*, 2015), and business model innovations (Burmeister, Lüttgens and Piller, 2016) are mentioned as key drivers of the digital transformation. Yet, literature reviews on the Industry 4.0 highlight that most publications on the subject are technology-centric (Liao *et al.*, 2017; Kamble, Gunasekaran and Gawankar, 2018). Liao *et al.* (2017) identified, in their literature review of 224 papers, the need “for a more detailed roadmap regarding the realisation of Industry 4.0” (p. 3621). Meanwhile, Kamble *et al.* (2018) highlighted the lack of studies on the guidelines for the successful implementation of Industry 4.0. These two literature reviews show there are few publications studying the Industry 4.0 as a digital transformation process and to the best of the authors’ knowledge, no literature review was published on this subject. To address this research need, we seek to identify gaps and research opportunities in the scientific literature on the digital transformation process, especially concerning the methods and guidelines to support organisational changes. A literature review methodology is applied to identify areas where further research is required, and provides a foundation for future studies (Webster and Watson, 2002). Specifically, we seek to answer the following question. Which transformation steps or stages are suggested in the existing literature on digitally transforming the organisations? To answer this question, we contextualize the existing stages model within the business area they intend to support and evaluate whether they are appropriate in the digital transformation context.

The answer to this analysis provides guidelines for a framework to support managers in their digital transformation process. The rest of this paper is organized as follow. In section 2, an early exploration of the literature is presented. Section 3 details the search design, while section 4 presents the content of the reviewed publications. A discussion about the state of literature and identified gaps and opportunities is presented in section 5, and finally the conclusion is presented in section 6.

2 Organisational transformation

Industry 4.0 is nowadays seen as a business transformation supported by technology rather than the opposite (Kane *et al.*, 2015). If several authors agree that the goal of the digital transformation is to bring organisations from a “non-digital” to a “digital” state, the business areas of transformations that are studied vary. The digital transformation motivates changes in several aspects of businesses. Business strategies are elaborated and serve as guidelines for the transformation (Kane *et al.*, 2015). Business models and value capture mechanism are adapted to the new context (Teece and Linden, 2017). Processes and work procedures can benefit from new technologies (Jenderny *et al.*, 2018). However, the introduction of new technologies and digitalised processes also have an influence on work design and leadership, two areas with less coverage in the literature (Schwarzmüller *et al.*, 2018). All these aspects should be considered to achieve a complete business transformation. In any cases, the transformation implies changes.

Managers and leaders are trying to foster acceptance and adoption of the digital transformation, which is the goal of organisational change management initiatives (Cameron and Green, 2015). However, organisational change is rarely fully predictable, due to the individual characteristics of employees and managers (Perkins, 2018). The transformation of the organisations introduces uncertainties that are gaining more research interest, even though many studies are still focussed on a specific domain of application or technology (Kamble, Gunasekaran and Gawankar, 2018; Schwarzmüller *et al.*, 2018). This difficulty to predict is exacerbated for the digital transformation, which is underway, where past experiences are limited (Schwarzmüller *et al.*, 2018). Some organisations implement changes in the value proposition without changing core activities, which introduces more tension and resistance to change (Akram, Bergquist and Åkesson, 2014). To adapt change management approaches to a specific context, one must understand the influencing factors. Structured and rigid change management approaches are more appropriate in contexts where there is little uncertainty, while in uncertain environment the issue is less on the formal management of change, and more on practices to favour a successful transition (Cameron and Green, 2015). Traditional change management approaches are often composed of a certain number of steps to be followed when the need for a change arise, but this method does not take into account the fact that change is often continuous (Weick and Quinn, 1999). It is

however not uniform, sometimes showing bumps, variations of scale or different level of predictability (By, 2005). Viewing change as a continuous and heterogenous process implies developing adaptation skills (Weick and Quinn, 1999; By, 2005).

In a business context, the skills governing the exploitation of resources are named capabilities (Pavlou and El Sawy, 2010). Capabilities can be reconfigured to adapt to changes in the environment, predictable or not. The skills to adapt to these changes are also capabilities, either dynamic when the future configuration can be planned, or improvisational when it cannot (Pavlou and El Sawy, 2010).

For the above reasons, the adaptation of change management approaches to the context of the digital transformation is of interest for managers, but to the best of the authors knowledge, this aspect has received little attention in the literature.

3 Review design

This study aims first at describing existing models and methods of the Industry 4.0 as a change process, then determining whether they are relevant in the context of the digital transformation. Finally, guidelines for future theoretical works are suggested. Literature reviews, especially in emerging fields, can help scholars develop theoretical foundations to support research (Webster and Watson, 2002). As evidenced in the exploration of the literature, appropriate factors include the business areas covered by the models as well as their fit with the current, uncertain environment. This study also aims at identifying gaps and opportunities in the literature about the process of digitally transforming the organisations. Literature reviews help with the identification of areas where further research is required, and provides a foundation for future studies (Webster and Watson, 2002). In management research, literature reviews have increasingly adopted systematic characteristics adapted from the field of medical sciences (Tranfield, Denyer and Smart, 2003; Okoli and Schabram, 2010). This methodology is well suited when a field of study is clearly established, but less so in emerging subjects where few studies have been published and a complete perspective on the subject has yet to emerge from the literature (Okoli and Schabram, 2010). In emerging fields of studies, literature reviews expose the need for theoretical foundations (Webster and Watson, 2002). In the case of the digital transformation, despite the high popularity of the subject, research is divided amongst several subjects, which makes for an overall low density of research (Kamble, Gunasekaran and Gawankar, 2018). In this context, the literature method used for this study provides a structure to limit bias from the researchers while preserving the ability to explore and discover new concepts (Tranfield, Denyer and Smart, 2003). The method used in this study is presented in Table 1, adapted from Tranfield *et al.* (2003) and Okoli & Schabram (2010).

1. Define purpose	Preliminary unstructured search and analysis of context
2. Literature search and criteria	Choice of databanks, search strings, inclusion and exclusion criteria, etc.
3. Data extraction	Collection of articles, evaluation of fit with criteria
4. Analysis and discussion	Read and analyse, presentation of results

Table 1 *Design of literature review, adapted from Tranfield et al. (2003) and Okoli & Schabram (2010)*

Existing views, models, and theories on the transformation process are summarized to highlight the gaps and research opportunities on the subject, the end goal being the suggestion of guidelines to support managers in the transition from traditional to digital organisations.

Peer-reviewed publications in five major databanks were selected, namely Science Direct, EBSCO-Business Source Complete, IEEE, ACM and ProQuest. These databanks were chosen because they include the major journals and conferences in information management, although no filter was added based on the publications included in the aforementioned databanks. The initial literature exploration revealed that two subject areas should be explored in addition to the stages of digital transformation: capabilities in the digital transformation and change management in the digital transformation.

The development of new capabilities is presented as an enabler to new business models (Teece and Linden, 2017), management approaches (Shamim *et al.*, 2016) and business structure (Fettig *et al.*, 2018). Organisations face constant changes of various amplitude, thus the ability to reconfigure itself to face change is essential (Weick and Quinn, 1999). This ability to reconfigure an organisation's operational capabilities to face current needs is named dynamic capabilities (Pavlou and El Sawy, 2010). Meanwhile, literature on the Industry 4.0 directly referencing organisational change or change management could provide insights to understand the current digital transformation (Hirte and Sieger, 2018). Table 2 details the search keywords. For all three searches, the string included terms related to the digital transformation in this form: (digital transformation keywords) AND (subject specific keywords).

Subject	Keywords separated with OR operator
Digital transformation	"digital transformation", "Industrie 4.0", "Industry 4.0", "smart factory"
AND	
1. Change process	Process, step, stage
2. Capabilities	"business capabilities", "digital capabilities"
3. Change management	"change management", "organisational change", "organizational change"

Table 2. Search keywords

Keywords were used to search in the abstracts of peer-reviewed journals and conference proceedings' full articles. Publications were screened first by a review of the abstract and then on a complete reading, by a single reviewer.

Inclusion and exclusion criteria help reduce subjective bias coming from the person reviewing the literature (Tranfield, Denyer and Smart, 2003). In this study, the initial inclusion criterion was formulated as such: "relevant publications discuss the digital transformation as a change process, and include a presentation of steps or stages of change in all organisational levels". However, the initial review yielded too few results, and inclusion criteria were extended to include publications on the change management approach and capabilities to support the change. Publications were excluded where full-text was not available or not in English, and where the digital transformation or the process of change were used only as a context description or in the future research orientations. The criteria are presented in Table 3.

Criterion	Description
Inclusion	Discuss the digital transformation as a change process AND
	includes a presentation of steps or stages of change in any organisational level OR
	includes a discussion on capabilities reconfiguration as a way to support change OR
	includes a discussion on change management approaches.
Exclusion	Full text is not available
	Publication is not in English
	Digital transformation is used only as a context rather than the object of study
	Process of change is not mentioned or not suggested

Table 3. Inclusion and exclusion criteria

The final number of unique publications is 30, including 15 publications on the change process, 6 on capabilities and 11 on change management. Two articles were included in several categories. The publications were manually coded by a single reviewer. The following section present the results of the data extraction while the analysis is presented in the discussion.

4 Results of review

The review of literature on the digital transformation process yielded 30 publications. First, we look at the subjects of transformation. Then, the models detailing steps or stages for the transformation are presented. Finally, we introduce studies about capabilities reconfiguration as success factors for the digital transformation.

4.1 Subject of transformation

The digital transformation covers several areas, or business subjects, in the organisations. The most commonly cited business subjects in the reviewed publications were business models and business processes, as shown in Figure 1. The transformation of business models includes changes to the value propositions (Akram, Bergquist and Åkesson, 2014; Ganzarain and Errasti, 2016; Müller, Buliga and Voigt, 2018), notably the integration of services (Exner, Zimpfer and Stark, 2017; Remane *et al.*, 2017), and the improvement or change of core competencies (Abersfelder *et al.*, 2016; Ketonen-Oksi and Järvi, 2018). Changes to business processes include definitions of tasks and work flows to address human factors (Jenderny *et al.*, 2018; Schafler *et al.*, 2018), work system design (Basios and Loucopoulos, 2017), and energy management in production processes (Nienke *et al.*, 2017).

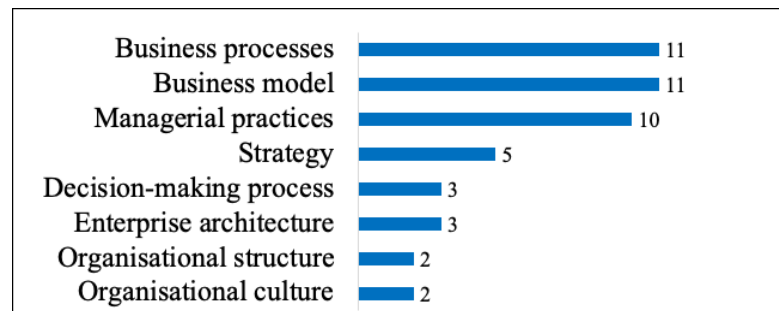


Figure 1. Number of publications by subject of transformation

Changes in managerial practices are also often mentioned, such as participatory change management (Trübswetter, Zettl and Glende, 2018), innovation management (Hirte and Sieger, 2018) and human resources management practices (Shamim *et al.*, 2016). Less commonly mentioned in the included publications are change management approaches for business strategy (Hansen, Kraemmergaard and Mathiassen, 2011; Schumacher, Erol and Sihn, 2016; Jantunen *et al.*, 2018), enterprise architecture (Bondar *et al.*, 2017; Weber *et al.*, 2017), and decision-making process (Dremel *et al.*, 2017). Finally, there are few mentions of changes to the organisational structure (Fettig *et al.*, 2018) and to the organisational culture (Shaughnessy, 2018).

4.2 Steps and stages of the digital transformation

Of the 30 publications selected in this study, 19 suggest steps or stages to digitally transform an organisation. The sample include several maturity models, as shown in Table 4. They cover a range of dimensions, from the socio-technical perspectives (Leineweber *et al.*, 2018) to energy management (Haag *et al.*, 2018). Other articles focus on structured steps akin to project management approaches. Some are directly inspired from Six Sigma DMAIC (Basios and Loucopoulos, 2017). Others suggest steps for digital project management, as “understand, ideate, select, design, evaluate” (Römer *et al.*, 2017), “analysis, requirements, concepts, implementation, validation” (Wank *et al.*, 2016), and “adjusting conditions, identification of ideas, concept generation, build concept, introduction of concept” (Batz, Kunath and Winkler, 2018).

Autors	Type of approach	Key concepts/ outcomes
Abersfelder <i>et al.</i> (2016)	Structured steps	"Preparation, Analysis, Creativity, Rating" Workshop structure, I4.0 projects
Basios and Loucopoulos (2017)	Structured steps	"Define, Measure, Analyse, Improve, Control" Develop capabilities for I4.0
Batz <i>et al.</i> (2018)	Structured steps	"Adjusting conditions, Identification, Concept generation, Build concept, Introduction of concept" Create a culture of innovation
Dremel <i>et al.</i> (2017)	Capabilities	"Advancing, Enabling, Leveraging" Stages of the evolution towards big data analytics
Exner <i>et al.</i> (2017)	Other	Degree of product and service offer, from pure product to pure service
Fettig <i>et al.</i> (2018)	Maturity model	6 level maturity scale according to three dimensions: HR development, work organisation and strategy
Ganzarain and Errasti (2016)	Maturity model and capabilities	5 level maturity model applicable to the transformation of the business model, for each of the stages in the "other" column "Vision, roadmap, projects" Stage to guide organisations to new diversification opportunities
Haag <i>et al.</i> (2018)	Maturity model	6 digitalization stages akin to a maturity model for smart energy management
Hansen <i>et al.</i> (2011)	Structured steps	"Initiate, analyse, debate, act" Steps to guide discussion between IT and business managers to adapt their approach to the digital transformation, especially Value of IT, Strategic orientation of IT and IS leadership roles
Ketonen-Oksi and Järvi (2018)	Capabilities	"Perceiving, prospecting, probing" Phases to re-position a service company for the digital transformation. Applied at different organisational level.
Leineweber <i>et al.</i> (2018)	Maturity model	Maturity model of business processes at different organisational level in 3 dimensions: technology, organisation, personnel.
Nienke <i>et al.</i> (2017)	Maturity model	4 level maturity model of data and information
Remane <i>et al.</i> (2017)	Capabilities	"Identify existing offer, deconstruct business model, discover new business model"
Römer <i>et al.</i> (2017)	Structured steps	"Understand, ideate, select, design, evaluate" Approach for business ideation and modelling
Schumacher <i>et al.</i> (2016)	Maturity model	5 level maturity model for I4.0 readiness according to 9 dimensions.
Trübswetter <i>et al.</i> (2018)	Capabilities	"Discovering, pathmaking, transforming" User-centered change approach for the digital transformation
Wank <i>et al.</i> (2016)	Structured steps and maturity model	4 level maturity scale of digitalisation "Analysis, requirements, concepts, implementation, validation" Process for digitalisation projects
Weber <i>et al.</i> (2017)	Maturity model	6 level maturity scale of data-driven manufacturing

Table 4. Description of publications concerning steps, stages and phases of the digital transformation.

Finally, as shown in Table 4, six publications discuss the digital transformation steps as neither a maturity model nor a structured project management approach. Dremel *et al.* (2017) suggest three stages to develop big data analytics, each stage lasting several years. Exner *et al.* (2017) detail the products

and services value proposition on a nine-level scale, the middle level being a true mix of products and services. Ganzarain and Errasti (2016) evaluate the maturity according to three stages of the digital diversification: vision, roadmap and projects of Industry 4.0. Ketonen-Oksi and Järvi (2018) suggest phases akin to the dynamic capabilities: perceiving, prospecting and probing. Remane *et al.* (2017) suggest identify existing offer, deconstruct business model and discover new business model. Finally, Trübswetter *et al.* (2018) suggest a user-centred change approach of discovering, path making and transforming.

4.3 Capabilities and key characteristics of the digital organisation

A recurring theme in the reviewed literature is the necessity for organisations to develop capabilities to successfully face the digital transformation (Karimi and Walter, 2015; Teece and Linden, 2017). While these contribute to the transformation, they are not formal stages since they are co-existing. Organisations evolving in a competitive market open to disruptions, to global competition, and in which products are increasingly complex can leverage the full set of capabilities available to them (Teece and Linden, 2017). These capabilities include traditional business capabilities such as technological proficiency, and dynamic capabilities represented by sensing, seizing and transforming capabilities (Teece and Linden, 2017). Dynamics capabilities have been linked to higher performances for new digital business models, especially sensing and reconfiguration (Jantunen *et al.*, 2018). They could help traditional companies face disruption of market by their competitors (Lucas and Goh, 2009). Classical project management approaches such as Six Sigma DMAIC can benefit from the integration of dynamic capabilities to introduce reconfiguration and flexibility in traditionally rigid methods (Basios and Loucopoulos, 2017). In the context of the digital transformation, capabilities related to innovation is a common subject. Innovative thinking leads to improved business capabilities (Karimi and Walter, 2015; Fettig *et al.*, 2018), new business structures (Fettig *et al.*, 2018), and new business models (Remane *et al.*, 2017; Teece and Linden, 2017). Shamin *et al.* (2016) suggest learning and innovation capabilities lead to a higher compatibility with Industry 4.0. Agility both in processes and in the organisational structure are also thought to contribute to adaptation to the modern business environment (Bondar *et al.*, 2017; Dremel *et al.*, 2017). Flexible and agile organisations are expected to better adapt to the technologically advanced environment (Fettig *et al.*, 2018; Jenderny *et al.*, 2018).

5 Discussion

This study aims first at the description of the models and methods of the digital transformation change management process, then determining whether they provide appropriate support for managers in the context of the digital transformation. The studies were classified in three categories shown in Table 4. There were several maturity models suggested in the sample, several approaches in structured steps, and finally approaches inspired from the development of dynamics capabilities. These studies share characteristics that will be discussed in addition to their differences.

5.1 Maturity models

Maturity models are useful to assess one's position compared to a pre-determined, ideal state (Schumacher, Erol and Sihm, 2016). They usually evaluate maturity according to one or several dimensions, such as business model (Ganzarain and Errasti, 2016) or technology (Weber *et al.*, 2017). Of the seven maturity models in this study, only two evaluate dimensions on more than one business area (Schumacher, Erol and Sihm, 2016; Fettig *et al.*, 2018).

Maturity models are used by organisations to identify their strengths and weaknesses, but do not often suggest mechanism to support the transformation (Schumacher, Erol and Sihm, 2016). This is illustrated in the seven maturity models included in this study. Some models give precise examples for each level, such as "production and order data connected to the product" (Wank *et al.*, 2016) or "actual and future project portfolio project detailed" (Ganzarain and Errasti, 2016). However, they do not offer guidance to improve. Schumacher *et al.* (2016) suggest offering a detailed view up to the items level

and providing industry benchmarks to enrich the understanding of the maturity assessment results. They recognize the need for the organisations to develop their own transformation roadmap (Schumacher, Erol and Sihn, 2016). Others use the maturity model as a basis for comparison and not for organisational level action (Fettig *et al.*, 2018).

Few maturity models discuss the value for organisations to reach the suggested ideal state. High levels of digitalisation is presented as good for a country's economic performances (Fettig *et al.*, 2018) and as a way to increase an organisation's efficiency and productivity (Weber *et al.*, 2017). "Digitalisation" is equalled to "performance", with little regard for contextual factors. While the digital transformation does offer ways for organisations to improve their performance, when the motivating drivers are mainly external, such as when answering to a market disruption (Lucas and Goh, 2009), improved efficiency and productivity are not the main concerns of the organisations. Finally, the digital transformation is not finished for a majority of organisations, and internal as well as external factors continue to change. Trying to reach a pre-determined state might not offer to organisations the flexibility they need for their transformation, or might cause them to overlook some challenges of change management.

5.2 Structured approaches

According to several authors, it is possible to structure early activities of the digital transformation like business model ideation (Römer *et al.*, 2017) or management of information technology and business alignment (Hansen, Kraemmergaard and Mathiassen, 2011). Steps help managers organise the transformation in a transparent and systematic way (Römer *et al.*, 2017). It also offers a framework to ensure participants' intake is considered (Hansen, Kraemmergaard and Mathiassen, 2011). A structured approach can also be used by organisations to develop an Industry 4.0 roadmap (Abersfelder *et al.*, 2016). These structured approaches can be deployed when the end goals are known and when it is possible to formalize the change process (Cameron and Green, 2015). Since the early days of research on change management, there have been evidence that routines help organisations be effective and improve their performance (By, 2005). Even though research recognise that organisations are constantly changing (Weick and Quinn, 1999), a structured approach can act as a routine to master the constant evolution in the environment (By, 2005). However, it is of little help when facing unpredictable change, or when the end goal can change with time. Uncertainty is present in the digital transformation context (Hansen, Kraemmergaard and Mathiassen, 2011; Trübswetter, Zettl and Glende, 2018) and organisations cannot easily know where they should go since most digital transformations are still in infancy (Schwarz Müller *et al.*, 2018). Thus, rigid change structures offer limited benefits in this context (Trübswetter, Zettl and Glende, 2018).

5.3 Phases of capabilities development

Instead or in addition to maturity models or structured steps for change, some authors suggest phases to provide organisations with winning conditions for the digital transformation, using vocabulary similar to the one employed in the study of capabilities. These studies answer a literature gap previously identified (Kamble, Gunasekaran and Gawankar, 2018). Four studies fit this description, as presented in Table 4, three of which are conceptual papers based on the experience of a single company. These studies present the digital transformation at a high level of abstraction, such as "discovering" (Trübswetter, Zettl and Glende, 2018) or "enabling" (Dremel *et al.*, 2017). These phases present similarities to the dynamics capabilities of sensing, seizing and transforming (Teece and Linden, 2017), as presented in Table 5.

	Sensing Look for insight, understand context and influencing factors, identify gap	Seizing Capture value, test, improve	Transforming Maintain organisational coherence, manage resources, close the gap
Teece and Linden (2017)			
Dremel <i>et al.</i> (2017)	"Advancing": analyse competencies, acquire resource, prepare budgets	"Enabling": build capabilities, pilot projects, conceptualise services	"Leveraging": implementation enterprise-wide
Ganzarain and Errasti (2016)	"Envision": study best practices, understand challenges and concepts	"Enable": choose appropriate technologies and capabilities, structure strategy in a roadmap	"Enact": projects, realize the roadmap
Ketonen-Oksi and Järvi (2018)	"Perceiving": build orientations, raise awareness "Prospecting": create new roles, identify concepts, use change agent	"Probing": create roadmap, seize new opportunities	
Trübswetter <i>et al.</i> (2018)	"Discovering": help employee visualize, provoke discussion, explore technologies	"Pathmaking": select appropriate methods, respond to change	"Transforming": exploit the change

Table 5. Similarities between dynamic capabilities and digital transformation change models

As with the maturity models, these phases help identify the state of the transformation at different organisational levels (Ketonen-Oksi and Järvi, 2018). While they are less precise than the maturity models because of their high abstraction level, they are also more flexible, with several phases co-existing or recognizing the possibility of going back while the transformation is not complete (Trübswetter, Zettl and Glende, 2018). However, if they are used alone they can cause frustration in organisations or even senses of powerlessness (Cameron and Green, 2015). Finally, as with the maturity models, these models do not help organisations implement the capabilities and does not indicate how they can facilitate the transformation.

6 State of research and research opportunities

Literature on the process of change in the context of the digital transformation has suggested maturity models, structured steps approaches and views linked to the development of dynamic capabilities as ways to manage the changes introduced in their organisations. By themselves, these approaches do not provide managers with a clear, single framework to identify their state of transformation and guide their change. However, together these categories present several elements that would be beneficial for managers. Structured steps contribute to making the transformation explicit, allowing more participation (Römer *et al.*, 2017). Organisations would benefit from a flexible change model (Trübswetter, Zettl and Glende, 2018) and the development of operational and dynamic capabilities (Teece and Linden, 2017) to account for some level of turbulence (Pavlou and El Sawy, 2010). As the unpredictability increases, an extension of the concept of dynamic capabilities like improvisational capabilities, which were not cited in the reviewed papers, could help organisations increase their flexibility when it is not possible to plan a configuration change (Pavlou and El Sawy, 2010). We tentatively represent visually the process of transformation acknowledging both the structure required, especially in the initial planning stages, and the need for a flexible approach to change enabled by dynamic and improvisational capabilities in Figure 2. As the transformation is not heterogenous and different actions are required on different subjects, we mapped the subjects treated in the reviewed articles as well as the number of articles on each in Figure 2. We distinguish according to the mention of dynamic capabilities, or similar concepts. This distinction highlights the fit of the approach with the constantly changing environment in which digital enterprises evolve.

Non-digital organisation	Vision	Strategy	Roadmap	Business model	0/3	Digital organisation
				Enterprise architecture	0/2	
				Organisational structure	0/2	
				Organisational culture	1/1	
				Managerial practices	2/2	
				Business processes	2/4	
				Related/Non-related to capabilities:	0/3	

Figure 2. Coverage of the recent literature on the digital transformation change process

The development of capabilities aims at the development of winning conditions by the reconfiguration of operational capabilities to better answer the current needs of the organisation (Teece and Linden, 2017), which is compatible with the need to facilitate the digital transition rather than trying to structure the change (Cameron and Green, 2015). The steps of visions and roadmap were mentioned in some publications as necessary to orient the transformation and make a good use of resources (Abersfelder *et al.*, 2016; Ganzarain and Errasti, 2016). For these steps, structured approaches to change could ensure participation from all categories of stakeholders and give greater transparency to the process.

The publications in this literature review cite several areas for the business transformation, from business process to business models. Some subjects such as organisational structure and organisational culture are less common in the study of the digital transformation than business processes and business models. Changes in organisational structures, such as flattened hierarchy and the integration of more tele-workers (Fettig *et al.*, 2018), and an agile culture (Shaughnessy, 2018) can contribute to more flexible and agile organisations, which might be better suited to face the digital transformation (Trübswetter, Zettl and Glende, 2018). However, these same changes cause leadership challenges and pressure on the work organisation (Schwarz Müller *et al.*, 2018) that are often neglected in the studies. New projects and new business model clash with the old business organisations, which can hinder progress or prevent real transformation (Akram, Bergquist and Åkesson, 2014). Furthermore, the studies describing the digital transformation as a series of steps or stages make little references to literature on organisational change and change management. Figure 2 illustrates gaps in the research on the digital transformation from a change management point of view. Notably, there is a relatively low number of publications across all subjects, but especially for the transformation of the enterprise architecture, the organisational structure and the organisational culture from a dynamic capabilities point of view. Moreover, few of the included studies were confirmatory studies with more than one case. The benefits of these models for the organisations still have to be demonstrated, ideally with several methodologies. Comparative studies based on cultural factors such as the work of Fettig *et al.* (2018) also demonstrate the impact of external factors, which should be considered in more future studies.

Finally, even though the search string included “change management”, few publications referred to the literature on change management. Hirte and Sieger (2018) reviewed the applicable change management literature, especially from the point of view of the middle managers. Technology disruption models were mentioned in two studies (Lucas and Goh, 2009; Karimi and Walter, 2015). Organisational learning and ambidexterity also were cited in a few studies (Akram, Bergquist and Åkesson, 2014; Shamim *et al.*, 2016; Exner, Zimpfer and Stark, 2017). However, the study of the process of digitally transforming organisations could benefit from more studies from the point of view of change management theories, both from an individual and from an organisational point of view.

7 Conclusion

The subject of the digital transformation and its strategic significance is understood by managers, but questions remain as to how to integrate digital solutions and how to modify business structures to transform into digital organisations. A professional survey and academic literature reviews have in the last year demonstrated the need to provide guidelines to help organisations transform. As budgets for the deployment of new technologies continue to rise, this need becomes more urgent.

This study contributes to research by providing a synthesis and suggesting theoretical foundations on the subject of the digital transformation. We examined the literature on the digital transformation from a change process point of view. The search yielded 30 publications that fit the inclusion criterion but not the exclusion criterion. The examination of these publications showed the study of the digital transformation and Industry 4.0 from a change management perspective has not yet reached maturity. While several studies offer useful models to help managers identify their digital level, manage their digital project or develop capabilities to facilitate a successful transformation, no framework supports managers in their overall digital transformation. We suggest the basis of a framework to visualise aspects of the digital transformation. Notably, we propose viewing the digital transformation as the continuous development of dynamic capabilities across several business subjects, such as the business model or the organisational structure. Some structure in the change management approach remains in the form of the development of a vision and a roadmap for the transformation. However, this model must be mindful of the changing nature of the environment, which calls for a flexible change management approach.

The results of this study have limits. First, only English keywords were used, which means publications in other languages have been overlooked. Second, a literature review in a field where the number of publications is limited, or in a field that has not reached maturity, can emphasize bias present in the existing literature. Finally, while the Industry 4.0 phenomenon is relatively new, the subject of the digital transformation is not, and it remains to be demonstrated whether the current iteration of the phenomenon is significantly different from the previous.

Several research opportunities were identified that could become the focus of future studies. Research on the digital transformation from the point of view of change management is seldom based on existing literature on change management. Furthermore, probably because the field is still in infancy, there are few confirmatory studies for the suggested models. Finally, future studies could focus on the development of a model to support the change process in the context of a digital transformation, and whether the current Industry 4.0 trend represents a different challenge than the previous digital transformation trends.

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